


***MERGING THE TEST & EVALUATION (T&E)
AND
MODELING & SIMULATION (M&S) WORLDS***



**PRESENTED AT:
THE NATIONAL SUMMIT ON U.S. DEFENSE POLICY:
ACQUISITION, RESEARCH, TEST and EVALUATION
LONG BEACH, CALIFORNIA
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**PRESENTED BY:
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BOOZ, ALLEN & HAMILTON INC.**

INTRODUCTION



- **Basic Issue**
 - **Real World (T&E) Has Remained Separate and Distinct From Simulated World (M&S)**
- **Results of Proof of Concept Project to Address This Issue**
 - **Booz, Allen & Hamilton Inc**
 - **XonTech, Inc.**

T&E HISTORY



- **1984 - OSD Chartered Joint Live Fire (JLF) Program to Investigate:**
 - **Survivability/Vulnerability and Lethality of Fielded Weapon Systems**
 - **Battle Damage Repair Procedures and Processes**
 - **Relevant Modeling and Simulation Capabilities**

T&E HISTORY (cont)



- **1986 - Congress Established Live Fire Test & Evaluation (LFT&E) Program**
 - **Realistic Survivability/Vulnerability and Lethality of Fielded Weapon Systems**
 - **Main Objective Was Component Level Vulnerabilities**
 - **Reports to Defense Committees of Congress Prior to Full-rate Production Decisions**
- **Nearly 100 Systems Have Been or Are Being Tested**
 - **Approximately 24 Are Major Defense Programs**

PROBLEMS



- **Costs Limit Number of Test Articles**
- **Only First Shot Is Into Virgin Structure**
- **Scheduling Constraints**
- **Limited Test Facilities**
- **Variability of Test Conditions**
- **Environmental Regulations**
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M&S HISTORY



- **M&S Has Played Secondary Role in T&E Arena**
 - **Primary Function Has Been Generation of Pre-test Predictions and Reconciliation of Post-test Results**
 - **LFT&E Program Office Requires Pre-test Predictions**
 - **Comparison of Pre-test Predictions and Post-test Results Provides M&S Baseline**
- **Model Inadequacies**
 - **Damage Phenomenology**
 - **Methodology Deficiencies**

LFT&E M&S INITIATIVES



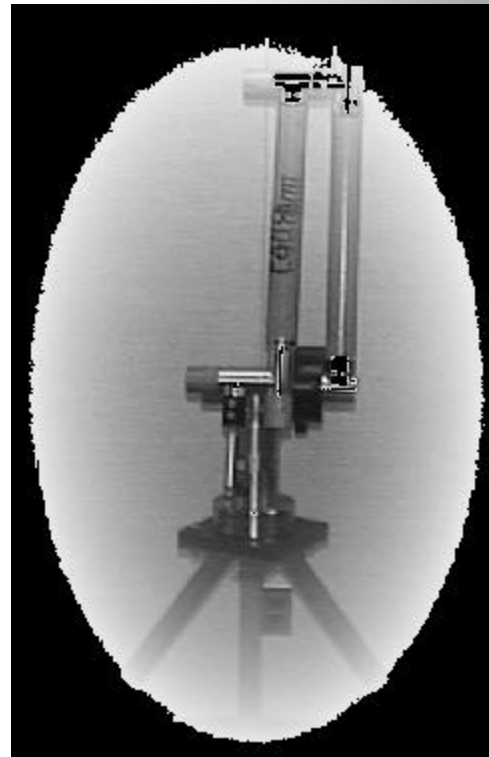
- **Simulation, Test, and Evaluation Process (STEP)**
 - Proposed by Dr. Paul Kaminski
 - Attempts to Make M&S Integral Part of T&E Process
 - Iterative Process Which Tries to Integrate Simulation and Testing to Evaluate Performance and Effectiveness
- **Modeling & Simulation Test & Evaluation Reform (MASTER)**
 - Proposed by Mr. James F. O'Bryon (OSD/DOT&E/LFT&E)
 - Overall Management Approach to M&S
 - Provide PMs With Most Realistic Models
 - Use Funding to Extend State-of-the Art

PROJECT DESCRIPTION

- **Used a JLF-damaged F-16 Wing at the Aircraft Survivability Research Facility (ASRF) at Wright Patterson Air Force Base**
- **Technical Challenge**
 - **Digitally Replicate Real World Phenomena**
 - **Create Accurate High Fidelity 3-D Model for Use in Finite Element Analysis (FEA)**
- **Approach**
 - **Data Gathered Using a COTS Coordinate Measuring Machine (CMM)**
 - **COTS Software Used to Create 3-D FEA Model**

CMM

- **Faro Arm Silver Series Model S08**
 - **Eight Foot Radius**
 - **Under Ideal Conditions, Single Point 2 Sigma Accuracy of +/- 0.003 Inch**



DATA COLLECTION



- **Considerations**
 - **Environment (Temperature Control)**
 - **Debris Accumulation**
 - **Large Area Measured => Placement of Arm With Respect to Wing and Damage Area**
- **Data Collection**
 - **Three 60 - 90 Minute Sessions**
 - **Features Recorded for Re-orientation Due to Movement and for Subsequent Sessions**
 - **Extra Data Collected for Rapidly Curving Surfaces**

PROCEDURE



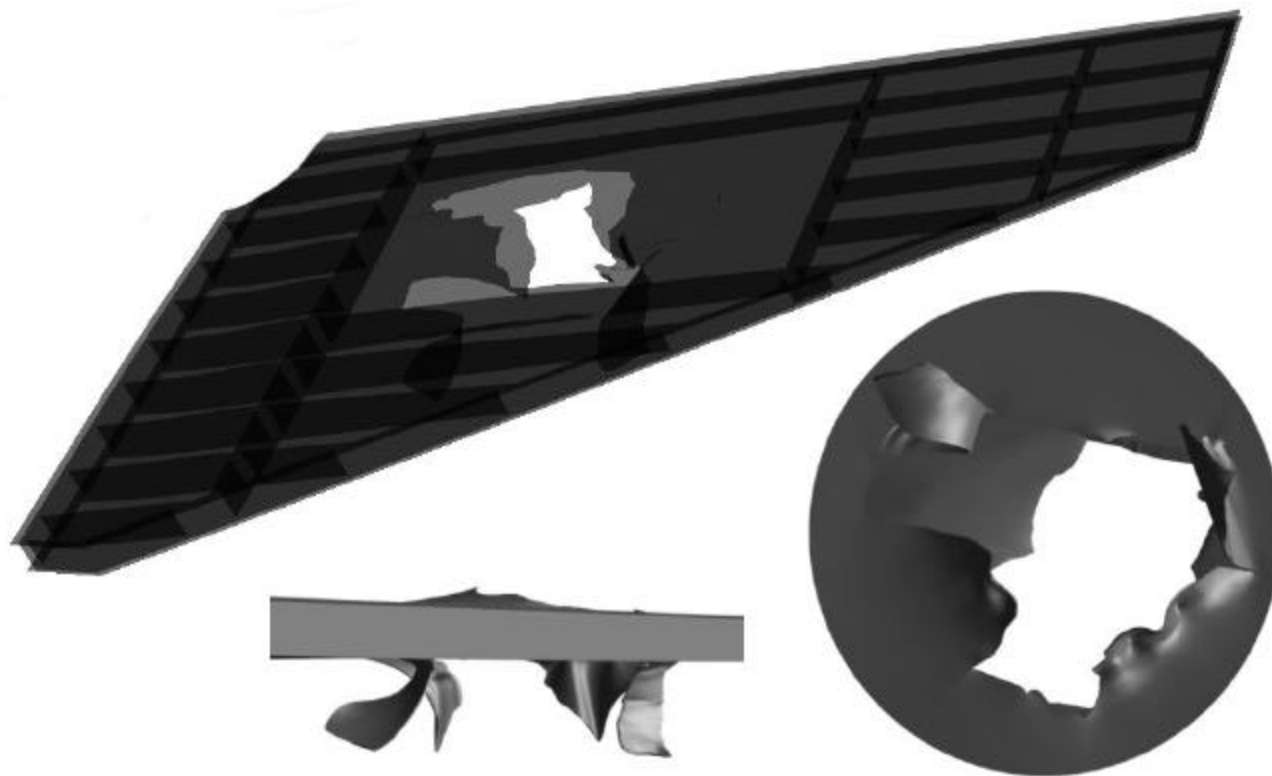
- **Collect Series of Points With CMM**
- **Use Modeling Package to Generate Solid Model Required for FEA Processing**
- **Solid Models Converted to Polygon Mesh**
- **Polygon Mesh Exported to FEA Program FEMAP**
 - **Finite Element Pre- and Post-processing Software**
 - **Able to Generate Input Files for All Major FEA Solvers**

RESULTS



- **File Read Successfully**
- **Preliminary FEA Conducted**
- **Digital Images Developed**
- **Time to Collect Data < 10 Hours**
- **Time to Construct Model - 60 Hours**

DIGITAL IMAGES



CONCLUSIONS



- **Process Demonstrated the Ability to Generate Models Suitable for FEA**
- **M&S Can Use These Models to Help Meet T&E Requirements for Realistic Survivability/vulnerability and Lethality Testing**
 - **Reduced Number of Test Articles Required**
 - **More In-depth Predictions**
 - **Mitigation of Consequences of Limited Virgin Structures**
 - **Elimination of Test Scheduling Difficulties and Test Condition Variability**

REQUIRED FUTURE ACTIVITIES



- **Validate Process With Addition Tests**
- **Develop Library of Threat/Material Interactions for Use in FEA**
- **Look at Other Technologies**
 - **Laser Scanner**
 - **Digital Photogrammetry**